



# THE WARRIOR

U.S. Army Soldier Systems Center

Natick, Massachusetts

March-April 2003

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Cover photo: Michael Holthe and Valerie Banville, project engineers at the Footwear Performance Lab, install a boot into the dynamic stiffness tester. (Warrior/Underhill)



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*The Warrior* is published bimonthly by the U.S. Army Soldier Systems Center Public Affairs Office in Natick, Mass., and is available online at:  
[www.natick.army.mil/warrior/index.htm](http://www.natick.army.mil/warrior/index.htm)

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U.S. Army Soldier Systems Center  
Internet links

<http://www.natick.army.mil>

<http://www.sbccom.army.mil>

Circulation: 2,750

*Printed by Document Automation and  
Production Service, Natick, Mass.*

# Food laboratory to fill out

**By Curt Biberdorf**  
Editor

The “Blue Palace” is set to become more palatial.

A \$4.1 million project approved in the 2003 Defense Appropriations Bill will expand the Department of Defense Combat Feeding Directorate laboratory at the U.S. Army Soldier Systems Center in Natick, Mass., into the existing unfinished second floor space.

The 18,650 square-foot expansion of the Food Engineering Lab, a two-year project with construction scheduled to begin later this year, brings some welcome changes.

“It’ll allow us to effectively use the space on the second level, bring some of the labs closer to where the work is being done and free up space in Research Building,” said Betty Davis, Performance Enhancement and Food Safety Team leader. “This is something that’s overdue.”

Two chemistry labs and five microbiology labs with office space, preparation rooms and instrument rooms; a new nanotechnology materials lab; two new temperature control rooms for 40 degrees F and 70 degrees F; and office space for 11 employees are the main features.



Warrior/Biberdorf

**Unfinished space on the second floor will include offices for 11 employees and new laboratories.**



Warrior/Biberdorf

**Part of the Food Engineering Laboratory’s second floor is now used for supply storage.**

The first floor food evaluation lab used for trained sensory panels will be relocated into one of the vacated chemistry labs.

“The temperature control rooms will give us extra capability we need to store operational rations undergoing shelf-life studies,” said Donald Hamlin, Food Engineering Services Team leader.

New and relocated stairwells, an

elevator for handicap-accessibility and two restrooms are also in the plan.

Construction is planned on the existing pre-framed second floor structure and will be spread out around the Food Pilot Plant and mechanical systems.

The project includes asbestos removal and repositioning existing utilities, equipment and ductwork within the new lab areas where there is a conflict between existing and new work.

Heating and cooling will be provided by tapping into and modifying existing systems.

The Soldier Systems Center’s Combat Feeding Directorate currently serves as the “one-stop shop” for all science and technology and advanced full-scale development of military rations, and Air Force, Navy and Marine Corps food service equipment and systems.

Furthermore, the U.S. Army Soldier Systems Center gives extensive engineering support to the Defense Logistics Agency for procurement of all subsistence items and ration systems to assure continued supply of high-quality, nutritious meals to its customers.

# Tex-tools

*Laboratory tests, evaluates fabrics to meet customer needs*

**By Curt Biberdorf**  
Editor

Stretching, breaking, tearing, weathering, fading and burning—the Textile Performance Testing Laboratory at the U.S. Army Soldier Systems Center in Natick, Mass., does this and more in studying the properties of textiles used in anything



Warrior/Underhill

**Break-strength testing applies forces from less than 1 ounce to more than 100,000 pounds.**

from button threads to sprawling tents to see if they stand up to the customer's requirements.

In November, the lab received accreditation for 53 tests for ISO 9001:2000 and ISO 17025:1999 from the International Organization for Standardization (ISO), making it the sole lab at the Soldier Systems Center to achieve this distinction.

It's equipped to perform more than 60 tests using standard test methodology from the American Society for Testing Material (ASTM) and American Association of Textile Chemists and Colorists (AATCC). When necessary, it creates unique tests to meet the customer's needs.

Customers from across the military, government and industry take advantage of the expertise of the textile technologists operating an array of equipment in evaluating standard textiles or materials in research and development.

"We're establishing quality standards for end-use, but it doesn't always predict performance in the field," said Vasant Devarakonda, Technical Support Services Team

leader.

Typically, project officers prepare a work request detailing the testing to be performed and submit it to technologists to evaluate and characterize the material's performance to assist project officers in down-selecting candidates. On the other hand, knowing desired specifications for a new material, technologists can evaluate a material to see if it meets those standards.

Six machines are available to test tensile strength, pulling materials with force ranging from less than an ounce to more than 100,000 pounds. Similarly, a pendulum-action machine applies up to 56 pounds of force to measure tear strength.

Another set of machines rub samples of fabric using as many as five different mechanical methods to measure abrasion and pilling to compare durability.

Water repellency and resistance tests help find the appropriate materials for outer garments and shelters. A hydrostatic pressure tester measures water penetration while spray testing measures beading and surface wetting.

Air permeability tests measure the airflow through a fabric. "This is critical for testing parachute fabrics and characterizing thermal insulation of clothing," said Nancy Hibbert, a textile technologist.

Colorfastness of dyes is determined by accelerated tests evaluating resistance to fading, weathering, color transfer by rubbing, bleaching, perspiration, washing and dry-cleaning.

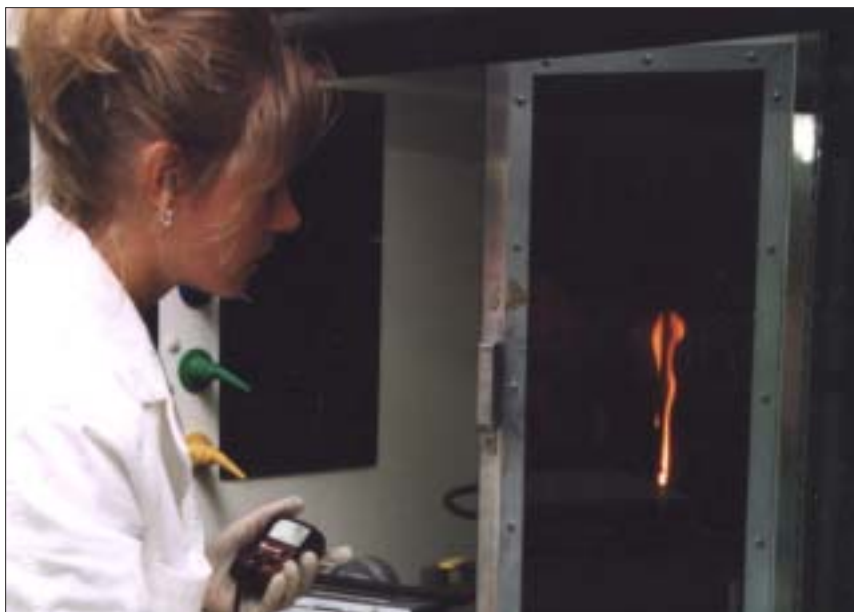
Susan Kuriothowski, also a textile technologist, evaluates flammability properties of materials, such as charring, melting, dripping, and degree of burn with the vertical flame test or thermal protection performance test.

"You have to find the appropriate test methodologies to test the material," said Luisa Santos, a textile chemist, who pointed out the new Marine Corps camouflage uniform



Warrior/Underhill

**Judy Sewell, a textile technologist, removes a piece of cloth from a "weather-ometer" machine used to evaluate colorfastness of dyes.**



Warrior/Underhill

**Susan Kuriothowski, a textile technologist, evaluates flammability properties of a fabric with the vertical flame test.**

as one the lab's more prominent projects in recent years.

For military products already in the system at Defense Supply Center-Philadelphia, technologists are called to certify government contract materials, provide technical support and identify alternate materials when needed. Technologists also interpret and analyze data and determine its affect on item serviceability. They support the quality control for Army clothing and accessories and provide textile-testing services for private entities.

Socks, underwear, Battle Dress Uniforms, Class A dress uniforms, rain jackets and fabrics used in footwear are among the standard items tested and evaluated.

"In the rare cases when there is no methodology that can predict performance, we've developed a new methodology," said Devarakonda.

Because of a test developed 22 years ago at the lab, properties of chemical-biological protective clothing can be screened before the garment proceeds with live-agent testing to save time and money, Santos

said. The lab also evaluates the shelf-life properties of chemical-biological protective garments.

More recently, the lab was tasked with developing a cleaning procedure to disinfect soldiers' parachutes that might be contaminated with hoof and mouth disease during training in Europe.

"This was particularly critical since most of the recommended procedures tend to adversely affect the tensile properties of the textile material," Devarakonda said.

The "bean bag" test created at the lab six years ago checks the durability of black color used in the woodland print pattern of all nylon-based materials. Before the test, he said the technologists found the black color in the Extreme Cold Weather Clothing System was being completely removed, but there was no way to predict it.

Beyond physical and chemical properties of materials, the lab studies the qualities that affect appearance, such as shrinkage and elongation, and smoothness and crease retention.

"We look at the seams and overall appearance of uniforms after multiple washings," said Judy Sewell, a textile technologist. "General officers want crisp-looking uniforms."

An upgraded shade room with improved lighting detects visual differences in fabrics to ensure uniformity in color between different manufacturers. The room's new spectrophotometer has more than double the range of the old model for measuring near-infrared properties of camouflage clothing.

"We're using the equipment to develop new specifications to make uniforms undetectable while wearing night vision goggles," said Melanie King, a textile technologist.

The technologists participate in committees of AATCC and ASTM to ensure that the textile facility stays updated on the latest developments in test methodology.

"Their commitment and dedication to provide its customers with professional service, accurate quality testing/data and to meet target schedules is clearly delineated in the laboratory's quality policy and most important practiced in their day-to-day activities," Devarakonda said.



Warrior/Underhill

**Melanie King, a textile technologist, ensures uniformity of color from uniforms produced by different manufacturers in the shade room.**

# Boot bash

**Footwear performance measured, examined in laboratory**

**By Curt Biberdorf**  
Editor

After thrashing through 100,000 cycles in a puddle of water, checking for a leaky boot is as simple as removing the piece of absorbent paper tucked inside.

"We beat up boots here. We beat the heck out of them," said Michael Holthe, lead project engineer for footwear programs at the U.S. Army Soldier Systems Center in Natick, Mass. "They have to be durable, but also help the person do their job. You could make a boot that lasts forever, but you really couldn't use it. It wouldn't be functional for the soldier."

The whole shoe flexer, modified for water penetration, is an often-used part of a collection of merciless machines gathered in the Footwear Performance Laboratory, the only facility of its kind in the Department of Defense. In operation for more than a year, the idea is to have one central location for technical testing or research and development for all military footwear, Holthe said.

"We're always trying to improve our users' products," he said. "We're lucky to have a facility with two trained people dedicated to studying the human performance aspects of footwear and materials testing."

Holthe and Valerie Banville, lab technician and project engineer, work primarily with the Army, Marine Corps and provide engineering support to Defense Supply Center-Philadelphia, but have helped the Navy and Air Force. Other jobs include testing footwear for law enforcement officers and firefighters under contract by the National Protection Center at the Soldier Systems Center. When time permits, industry can pay to use the lab's equipment.

One of the bigger contracts currently is the Army's new Infantry Combat Boot. Holthe and Banville are taking product demonstration models from different manufactur-

ers that are submitting bids to check that they pass existing performance specifications.

When they're not checking product models, they may be adjusting existing performance standards to enhance performance, safety, comfort and durability, or researching and developing new boots.

"When it comes to boots, it's a different sort of item," Holthe said. "They can affect oxygen consumption, fatigue, and marksmanship in addition to lower leg injuries. We need to make footwear function in many environments but also protect the soldier and help him do the job more efficiently."

Military boots are categorized as extreme cold, cold-wet, temperate, hot weather wet and dry, and blast protective. The only footwear they don't currently handle is chemical-biological protective.

Besides the Infantry Combat Boot, other projects in progress or upcoming are improved hot weather combat boots for the Army, the Army's new modular footwear program and improving the current blast protective footwear used by Army engineers.

"In the past we would always tell industry what to make," Holthe said. "It's changed in that we do a lot more work with industry in determining what new footwear and component technologies are available and how we can implement them into our footwear quickly and efficiently to give our users added capability and safety."



Warrior/Biberdorf

**The heated sandbath measures temperature change inside a boot.**



Warrior/Biberdorf

**Valerie Banville, lab technician and project engineer, places the lid on the whole shoe flexer, modified for water penetration.**

Their research is sometimes collaborative between the U.S. Navy Clothing and Textile Research Facility and U.S. Army Research Institute of Environmental Medicine, both located on the installation, as well as the Textile Testing Facility at the Natick Soldier Center.

Equipment in the lab was assembled to create a specialized ability to test and evaluate footwear and checks heat insulation, shock attenuation, pressure distribution, water penetration, flex resistance and dynamic stiffness.

"None of this replaces field testing, but it helps us know if an item is going in the right direction. We can do the pre-testing here so we don't waste time," Holthe said.

## Flexing leather

A dry and wet testing version of the whole shoe flexer sits atop a black counter inside the lab. Once it's set up for flex angle and fitted with a boot, the machine pivots up and down along the boot's natural flexing line for a 12-hour test, cycling 140 repetitions per minute to assess the resistance of an item of footwear to repeated flexing. The boot is visually examined for damage. It produces results similar to having a soldier wear the boot in months of field use, according to Holthe.

For the wet version, only one intact boot is placed inside the machine where a stainless steel tank is filled with enough water to cover up to the ankle. It's pass or fail if the paper inside remains dry or gets wet.

"It does its job great," Holthe said. "The test we used to use didn't provide a real-world type application. This lets us know if it stays waterproof during wear and tear."

Similarly, the dynamic stiffness tester measures longitudinal and torsional stiffness, but unlike the flexer, data can be collected.

"What we can do is determine the flexibility to see how a boot changes as it's broken-in and then find the break-in point," Holthe said.

## Softer strike

Used more as a research and development tool, the impact tester slams a steel piston onto a separate



Warrior/Biberdorf

**The in-shoe pressure measurement device records data from sensor-embedded insoles worn by a human research volunteer.**

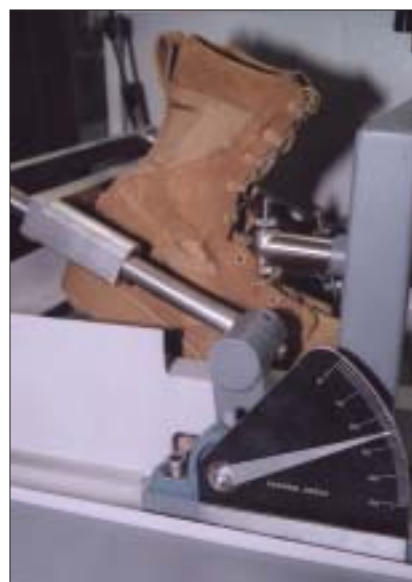
midsole or onto the entire manufactured boot sole system to assess shock attenuation, energy return and material deformation. A computer registers deceleration, a measurement of how much the material is absorbing the impact and time it takes to stop and rebound to its original shape.

"We're trying to find a way to protect our users. Much of the population currently entering the military is used to wearing cushioned soles," Holthe said. "Research has shown that, even with seasoned soldiers, providing enhanced shock attenuation leads to less lower leg injury, less down time for the soldier which translates into less money lost by the military as well as added capability for our warfighters."

Also helpful in research and development, the in-shoe pressure measurement device records data from sensor-embedded insoles placed inside footwear worn by a human research volunteer. By measuring impact and pressure along the entire length of his foot, researchers have an uncommon capability.

Data is logged with a portable device carried by the research volunteer either in a lab study walking on a treadmill or in a field study.

Heat insulation is another property the lab can measure. The heated sandbath consists of a metal tray incorporating a hotplate filled with sand. The entire sole is covered in sand heated to 150 degrees C. A probe is placed inside to measure the temperature increase. The



Warrior/Biberdorf

**A hot weather boot undergoes dry testing with the whole shoe flexer.**

standard is a temperature increase no higher than 22 degrees C in 30 minutes.

More than gauging comfort, the sandbath helps assess flame and heat protection required for aviators, according to Holthe.

The Army's Infantry Combat Boot is an example of the success of the footwear program, which hopes to expand in capability by bringing in more equipment and conducting more tests.

"To have one style of footwear for 450,000 people and get more than an 80 percent approval rating makes us feel like we're moving in the right direction," Holthe said.



Courtesy photo

**The Sherpa exits an Air Force C-130 during testing at the U.S. Army Yuma Proving Ground, Ariz.**

# On target

## *Sherpa drops supplies, equipment accurately*

**By Curt Biberdorf**  
Editor

“Dumb” airdrop is getting “smart.”

Precision-guided munitions have successfully pinpointed aerial bombings for years, and the same idea is being researched for airdropping supplies and equipment. One system identified and tested by the Airdrop Technology Team at the U.S. Army Soldier Systems Center could soon vastly improve the way the military drops extra-light loads of supplies.

The Sherpa Autonomous Parafoil Delivery System developed by Mist Mobility Integrated Systems Technology (MMIST) Inc. in Ontario, Canada, is a commercial off-the-shelf item that enables servicemembers on land to get what they need almost exactly where they want it.

“When you drop a dumb parachute system from high altitudes, it can drift away and you may not find it quickly,” said Jaelyn McHugh, project officer for the Sherpa. “The Special Forces say this system is amazing. They’ve had to hike between 1-3 kilometers to find their

supplies with current airdrop systems.”

The Sherpa, a mature product, is one of many “just-in-time” resupply systems in its payload-weight class of the Airdrop Technology Team’s Precision Extended Glide Airdrop Systems (PEGASYS) Demonstration, according to Richard Benney, Airdrop Technology Team leader.

With the Sherpa, transport aircraft or helicopters at altitudes of 5,000-25,000 feet and as far as 9 miles away can dispatch supply pallets weighing 400-1,200 pounds to within 200 meters of the target location.

To get close to this accuracy, Benney said current airdrop systems with round parachutes are pushed out at altitudes under 1,000 feet, which exposes aircraft to enemy fire and minimizes stealth.

In more than 30 drops in testing, the Sherpa has been effective and reliable. It was most recently successfully demonstrated to soldiers at Fort Polk, La., in February.

The Sherpa flies autonomously with a Global Positioning System (GPS), by remote control, guided by a beacon or by a combination of the methods.



Courtesy photo

**Once the parafoil opens, servo-actuators in the control unit steer the load left or right by pulling down the parafoil’s trailing edges.**

For autonomous flight, an operator enters critical information, such as altitude, mass, wind and target point, into a computer and downloads it into the Sherpa’s parachute control unit before pushing out the cargo.

Once out of the aircraft, a parafoil opens and servo-actuators in the control unit steer the load left or right by pulling down the parafoil’s trailing edges as the Sherpa’s GPS receiver determines the coordinates of its own position from the parameters entered into the system. The system guides itself to within 100 meters of the target coordinates.

“If it goes too far, it’ll just turn around and fly to the location,” McHugh said. “The system’s simple to learn and easy to operate.”

When directed manually by a trained operator on the ground or in the air, landing accuracy for remote control is limited only by the operator’s skill. A manual remote override capability enables users to switch between remote control and autonomous flight.

By activating a beacon transmitter on the target site, the Sherpa can also be programmed to home in and land within 200 meters of the signal.



Courtesy photo

**The Sherpa closes in on the target. The system can use one or a combination of the three flight modes and lands in one of three modes depending on desired accuracy and impact speed.**

As it approaches the target, the Sherpa lands in any of three modes.

At 4,500 feet, the cargo follows an 80-meter-radius circle around the target in the spiral mode by pulling on the steering line with each pass to create a tighter turn radius until landing. The direct landing is used for high accuracy. However, the load can hit the ground hard because it can land in the same direction as the wind and does not flare, which is the rapid slowdown from retracting both sides of the parafoil.

When accuracy is less important, the Sherpa in the approach mode follows the same 80-meter circle but turns into the wind to lower its speed for a softer landing, which is important for more sensitive items, such as medical supplies, according to McHugh.

The remote control mode has benefits over both spiral and approach modes. "Using the remote control is an advantage with the direct landing because the operator can flare the parafoil for a softer landing," McHugh said.

Once on the ground, the Sherpa can be recovered during de-rigging for further drops.

Limited fielding of the item to Army units is going to depend on how well the capabilities of the current Sherpa match their needs, according to Benney.



Courtesy photo

**The cargo load lands within 200 meters of the intended target. The Sherpa is recoverable for further airdrops.**



Soldiers move into a newly-constructed Force Provider in Kuwait. Force Provider modules are supporting more than 6,000 members of the coalition forces in the country as well as housing soldiers engaged directly in continuing combat operations in Afghanistan.

## *'Tent cities' move forward*

*Story by Michael Gallagher and Michael Hope  
Photos by Bob Whistine*

Originally conceived as a rear area rest and refit facility, Force Provider (FP) is now a combat multiplier being used as a forward deployed system that increases combat capabilities by providing superior living conditions beyond that ever experienced by soldiers.

FP is a readily deployable, containerized and pre-packed base camp developed by the Army between 1992-1994. Using flexible configurations of tents and containerized systems, each FP module can support about 550 people and offers quality of life amenities not normally found in the field.

Among the wide variety of containerized and rapidly deployable systems that make up FP are air-conditioned tents, hot showers, a full-service kitchen, on-site laundry service and flushing toilets.

Other amenities include recreation such as basketball, table tennis and satellite television. Each module also offers a chapel and a small medical facility for use by the visiting unit's staff.

Five modules were deployed and set up near Kandahar last June,

housing soldiers engaged directly in the continuing combat operations inside Afghanistan.

FP is managed by Product Manager-Force Sustainment Systems (PM-FSS) located at the U.S. Army Soldier Systems Center in Natick,



**A third country national unloads a container packed with Force Provider materials.**

Mass. PM-FSS is an element of Project Manager-Force Projection within the Program Executive Office for Combat Support and Combat Service Support (PEO-CS&CSS).

As the system life-cycle manager, PM-FSS continually seeks new ways to support unified commands with better equipment that can arrive and be operational faster than ever before.

FP is an important component of how PM-FSS supports Project Manager-Force Projection's vision of being the preferred provider of systems that move and sustain today's transforming Army.

With its systems that can be rapidly deployed by air, sea or land, and then rapidly employed once delivered in-theater, FP improves the Army's combat capability by providing a strategic force-projection presence while providing soldiers a greatly improved quality of life.

These improved conditions boost morale, which in turn allows warfighters to be better prepared to execute their missions.

This vision has played itself out



**Third country nationals lay down wood flooring as the foundation for Force Provider tents in Kuwait.**

well in Operation Enduring Freedom.

When deployed, FP uses and is dependent on a multitude of CS&CSS equipment, including power generation, water purification and delivery systems, materiel handling equipment, tactical vehicles and Army watercraft.

The recent stand-up of PEO-CS&CSS aligned the product managers of the above systems under a single umbrella that allows for close communication, collaboration and synchronization of efforts resulting in a better end-product that meets the Army's requirements.

FP has proven to be extremely flexible and versatile given the changing conditions. After Sept. 11, 2001, the Army was called upon to work jointly with the Air Force and the U.S. Special Operations Command (SOCOM) to provide combat, combat service and combat service support to operations in and around Afghanistan.

In October 2002, the Army began to deploy, set up and operate overseas-based FP modules in support of Operation Enduring Freedom. In November, seven FP modules were in transit to the theater of operations. By the end of December, these systems were established and provided an early entry capability that served as the first forward base camp facilities to directly support air and ground combat opera-

tions inside Afghanistan.

FP modules were employed at two sites. In Uzbekistan, they were operated entirely by the Army and provided support to SOCOM, Army and coalition forces. In Kyrgyzstan, Air Force personnel set up and operated the base camp strictly for airfield operations.

At both sites, Air Force Harvest Eagle/Falcon base camps, similar to FP, were collocated with the FP equipment, proving that FP offers a joint capability.

FP modules serve multiple roles as base camps, Intermediate Staging Bases and in-theater reception, and more of the modules are being deployed as coalition forces have increased in the region.



**A sewer system for Force Provider is installed in Kuwait with the help of heavy machinery.**

FP first deployed in July 1994 to Grand Turks Island during the Atlantic Command's preparation for military intervention in Haiti. Since then, FP has served in military operations in Guatemala, Cuba, Honduras and the Balkans. Currently 32 of 36 planned modules exist, more than half of which are either deployed or being refurbished from recent deployments.

Ongoing combat operations are extremely demanding, and the Army's ability to bring superior living conditions to the soldier increases recovery time and makes for a more effective combat soldier.

From the chilly temperatures of Kyrgyzstan in January to the 120 degree F heat in Kandahar, Force Provider has been supporting the force to unprecedented levels.

Shortly after the 82nd Airborne Division moved into the FP facilities near Kandahar, "Stars and Stripes" European Edition on July 28, 2002, reported the division's soldiers expected typically poor living conditions.

However, when they arrived at Kandahar Airfield, "most soldiers were shocked by the conditions. They could not believe they were so good."

*Editor's Note: Michael Gallagher is assistant product manager for FP, PM-FSS. Michael Hope is chief, Combat Field Service Equipment Team, PM-FSS. Bob Whistine is the Army Materiel Command-Logistic Support Element public affairs officer.*